THE DESIGNS AND PERFORMANCE OF MAXILLARY COMPLETE DENTURES IN PATIENTS WITH TORUS PALATINUS

by

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Thesis submitted in fulfillment of the

requirements for the degree

of Master of Science

November 2010

Dedication

For my family and my wife, who offered me unconditional love and support throughout this thesis.

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ACKNOWLEDGEMENTS

I would like to place my great appreciation and sincere thanks to the following individuals for their invaluable contributions during the conduct of this study and the preparation of this thesis.

- First and foremost is my supervisor, Dr. Norhayati Luddin for her continuous support, patience, motivation and enthusiasm in helping me to complete this project. Her guidance has helped me tremendously during the time of my study. I could not have imagined having a better advisor and mentor.

- Next, to my co-supervisors, Dr. Adam Husein, Dr. Yanti Johari and Associate Professor Dr. Zainul Ahmad Rajion, as well as Dr. Hashima Ibrahim, Matron Asiah Munadi and all the staffs at the Polyclinics and Pedodontic Clinic.

- Dr Basaruddin Ahmad for his expert analytical and statistical contributions to this project, Associate Professor Dr. Hj. Abdul Rashid Bin Hj Ismail, Professor Dr. Zulkifli Ahmad, Ms Haizan, Ms Faridah, Ms Wan Nor Azlin and all the staffs at the School of Dental Sciences, Universiti Sains Malaysia, for their endless support.

- All the patients and who had either directly or indirectly contributed to this study.

- All my colleagues in the School of Dental Sciences, Universiti Sains Malaysia for their friendship and continuous support throughout my stay here.

Thein Aye Zaw

20th November 2010

SIGNED STATEMENT

This work contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I gave consent to this copy of my thesis, when deposited in the University Library, being available for loan and photocopying.

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ABSTRAK

Kajian ini bertujuan mengkaji reka bentuk dan prestasi gigi palsu lengkap rahang atas dalam kalangan pesakit torus lelangit. Impresi rahang atas pada 150 pesakit dengan torus lelangit/palatinus telah diambil dan kajian tuangan telah diperoleh dengan menggunakan batu kuning (Calstone, France). Saiz torus lelangit untuk tuangan individu diukur menggunakan MyCast (dipatenkan di Universiti Sains Malaysia) dan perisian Australis, Versi 6.01 (Photometrix Australia) dan digredkan pada kecil, sederhana dan saiz *besar/bertanda.* Pesakit dengan torus lelangit kecil, sederhana dan saiz torus lelangit *besar/ bertanda* serta memakai gigi palsu lengkap rahang atas telah dipanggil untuk temu janji (n=20 pesakit bagi setiap kumpulan). Reka bentuk (liputan penuh atau ladam) pada gigi palsu lengkap rahang atas pesakit diperiksa dan direkodkan. Di samping itu, gigi palsu telah diperiksa untuk pegangan dan kestabilannya menggunakan Soal Selidik Peperiksaan Pemakanan dan Kesihatan Kebangsaan (NHANES III, peperiksaan dan fail data dewasa, 1988-1994). Kepuasan pesakit yang memakai gigi palsu turut dinilai dengan menggunakan soal selidik yang telah disahkan. Data telah dimasukkan ke dalam perisian SPSS dan dianalisis menggunakan ujian khi-kuasa dua. Keputusan dengan p <0.05 dianggap penting dari segi statistik. Kajian ini mendapati bahawa min bagi panjang, lebar dan ketinggian torus lelangit masing-masing ialah (23.18 mm ± 3.78), (14,84 mm ± 1.61) dan (3,53 mm ± 1.32). Antara 150 pesakit, 71 (47.3%) saiz kecil, 59 (39.3%) saiz sederhana dan 20 (13.3%) saiz torus lelangit *besar/ bertanda* telah dijumpai. 43 pesakit lelaki (28.7%) dan 107 (71.3%) pesakit wanita dengan torus lelangit juga direkodkan. Nisbah lelaki kepada perempuan ialah 1:2.5. Keadaan torus lelangit

sering dijumpai pada usia 40-59 tahun. Dalam kalangan 60 pesakit yang mempunyai saiz torus lelangit yang berbeza, 24 bentuk ladam dan 36 reka bentuk gigi palsu penuh liputan telah ditemui. 38 pesakit telah memakai gigi palsu yang dapat memegang manakala 22 pesakit mempunyai gigi palsu yang tidak dapat memegang. Selain itu, 37 pesakit dengan gigi palsu yang stabil dan 23 pesakit dengan gigi palsu yang tidak stabil telah ditemui dalam kajian ini. Kepuasan memakai gigi palsu rahang atas biasanya dijumpai pada saiz kecil dan sederhana berbanding pada pesakit dengan saiz torus lelangit *besar/bertanda*. Kesimpulannya, min ukuran panjang, lebar dan ketinggian torus lelangit ialah masing-masing 23.18 mm (SD 3.78), 14.84 mm (SD 1.61) dan 3.53 mm (SD 1.32). Torus lelangit saiz kecil (47.3%) merupakan saiz yang paling biasa yang ditemui dalam kajian ini daripada sederhana (39.3%) dan saiz torus lelangit *besar/bertanda* (13.3%). Torus lelangit paling biasa ditemui dalam kalangan wanita berbanding lelaki tetapi keputusan tidak menunjukkan sebarang perbezaan yang signifikan. Torus lelangit biasanya ditemui dalam kumpulan umur 40-59 tahun tetapi keputusan adalah tidak signifikan. Terdapat perbezaan yang signifikan antara reka bentuk gigi palsu lengkap rahang atas (ladam dan liputan penuh) pada pelbagai saiz torus lelangit. Bagi pesakit yang dikenal pasti mempunyai torus lelangit *besar/bertanda,* reka bentuk gigi palsu liputan penuh (20%) telah dibuat kurang daripada reka bentuk gigi palsu ladam (80%).Terdapat perbezaan yang signifikan antara pegangan gigi palsu lengkap rahang atas dengan saiz yang berlainan bagi torus lelangit. Pegangan gigi palsu lengkap rahang atas adalah lemah dalam pesakit yang mempunyai saiz torus lelangit *besar/bertanda* (80%) sedangkan ia baik kepada pesakit dengan torus lelangit saiz sederhana (75%) dan kecil (95%).Terdapat perbezaan yang signifikan antara kestabilan gigi palsu dengan saiz torus lelangit yang berlainan. Walaupun kestabilan gigi palsu lemah dalam kalangan pesakit

dengan saiz torus lelangit *besar/bertanda* (80%), ia adalah baik pada pesakit dengan torus lelangit saiz sederhana (70%) dan kecil (95%). Perkaitan signifikan ditemui antara kepuasan gigi palsu dengan saiz torus lelangit yang berlainan. Pesakit dengan saiz torus lelangit *besar/bertanda* mempunyai kepuasan gigi palsu yang kurang daripada pesakit dengan torus lelangit saiz sederhana dan kecil.

THE DESIGNS AND PERFORMANCE OF MAXILLARY COMPLETE DENTURES IN PATIENTS WITH TORUS PALATINUS

ABSTRACT

The aim of this study was to examine the designs and performance of maxillary complete dentures in patients with torus palatinus. Maxillary impressions of one hundred and fifty patients with torus palatinus were taken and study casts were obtained using yellow stone (Calstone, France). The size of torus palatinus for individual cast was measured using MyCast (patented at Universiti Sains Malaysia) and Australis software, Version 6.01 (Photometrix, Australia) and graded into slight, moderate and marked size. Patients with slight, moderate and marked torus palatinus who were wearing maxillary complete denture were called for an appointment (n=20 patients for each group). The designs (full coverage or horse-shoe) of the patient's maxillary complete dentures were examined and recorded. In addition, the dentures were examined for its retention and stability using National Health and Nutrition Examination Survey (NHANES III, examination and adult data files, 1988-1994). The patient's satisfaction upon wearing the denture was also assessed using a validated questionnaire. Data was entered into SPSS software and analyzed using chi-square test whereby results with $p<0.05$ was considered statistically significant. This study found that the mean for length, width and height of the torus palatinus were (23.18 mm ± 3.78), (14.84 mm ± 1.61) and (3.53 mm ± 1.32) respectively. Among 150 patients, 71 (47.3%) slight, 59 (39.3%) moderate and 20 (13.3%) marked size torus platinus were found. Fourty three male patients (28.7%) and 107 (71.3%) female patients with torus palatinus were also recorded. The male to female ratio was 1:2.5. Torus palatinus was most commonly found in 40-59 years of age. Among 60

patients with different sizes of torus palatinus, 24 horse-shoe and 36 full coverage denture designs were found. 38 patients were wearing retentive denture while 22 patients were having non retentive denture. Moreover, 37 patients with stable dentures and 23 patients with unstable dentures were found in the present study. Satisfaction of wearing maxillary denture was commonly found in slight and moderate size compared to marked size torus palatinus patients. In conclusion, the mean measurement for length, width and height of torus palatinus were 23.18 mm (SD 3.78), 14.84 mm (SD 1.61) and 3.53 mm (SD 1.32) respectively. Slight size torus palatinus (47.3%) was the most common size found in the present study than moderate (39.3%) and marked (13.3%) size torus palatinus. 43 (28.7%) male patients and 107 (28.7%) female patients with torus palatinus were found but no significant difference between gender and size of torus palatinus. Torus palatinus was commonly found in 40-59 years age group but no significant difference was found between age group and size of torus palatinus. There was a significant difference between the designs of maxillary complete denture (horse-shoe and full coverage) amongst the different sizes of torus palatinus. The full coverage denture design (20%) was constructed less than horse-shoe denture design (80%) for patient with marked torus palatinus. There was a significant difference between the retention of maxillary complete denture and different sizes of torus palatinus. The retention of maxillary complete denture was poor in patients with marked size torus palatinus (80%) whereas it was good in patients with moderate (75%) and slight size torus palatinus (95%). There was a significant difference between the stability of denture and different sizes of torus palatinus. Although the stability of the denture was poor in patients with marked size torus palatinus (80%), it was good in patients with moderate (70%) and slight size torus palatinus (95%). A significant association was

found between denture satisfaction and different sizes of torus palatinus. Patients with marked size torus palatinus have less denture satisfaction than patients with moderate and slight size torus palatinus.

CHAPTER ONE

INTRODUCTION

1.1 Study Background

Nowadays, the number of adults losing their natural teeth is diminishing because of improvements in oral care. However, there are still large numbers of edentulous adults all over the world. In the United States, the estimated elderly population of 2002 showed that 13% of population aged 65 years of age or older were edentulous. By the year 2050, this percentage is expected to double, with the significant increase also expected world wide (Hummel *et al.*, 2002). A study involving Korean population showed that only 3.9% of adults over 65 years of age have all of their natural teeth in the Korean population (Lee *et al.*, 2010). It has also been reported that the absolute number of edentulous patients needing care is actually increasing (Allen and McCarthy, 2003a).

Within Malaysia, a higher proportion of health-conscious ageing population will retain their natural teeth and demand more care. Nevertheless, dental epidemiological survey of adults in Malaysia indicated that edentulousness in the Malaysian population is still high in older people. Edentulous people wearing prosthesis are shown in table 1.1 (Oral Health Division and Ministry Of Health Malaysia, 2004).

Table 1.1: Dentition Status and Prosthetic Status in Malaysia, 2000

Dentition Status	Estimated Population	%Without prosthesis	%With prosthesis
Edentulous	863,923	14.1	85.9
Dentate	9,661,564	78.8	21.2
Total	10,525,487	73.5	26.5

Nevertheless, current data showed that patients are keeping more teeth longer, this is demonstrated by the fact that 71.5% of 65 to 74-year-old individuals are edentulous (John *et al.,* 2004). Replacement of missing teeth will be a common patients' need and they will demand it well into their elderly years. Therefore, partially edentulous or fully edentulous patients can be appropriately provided with comfortable and useful tooth replacements in the form of removable partial dentures or removable complete dentures (Allen and McCarthy, 2003a). As a replacement, denture appliance is used for restoration, maintenance of oral function and appearance (Carr *et al.*, 2005).

Retention, stability and support are the three key principal factors in the prescription and provision of successful dentures (Sutton, 2007). Retention is usually the distinguishing factor between success and failure of dentures (Wright, 2004). Retentive denture is free from movement in the vertical plane, away from the tissue along the path of displacement or opposite the path of insertion. Retention mainly depends on peripheral seal, interfacial seal and posterior palatal seal (Rendell *et al.*, 1995). Stable denture does not move in the horizontal plane. Stability relies on resisting forces likely to displace the denture from the denture-bearing tissues (Rendell *et al.*, 1995). Denture design and dental arch abnormalities such as cleft palate and torus palatinus influence retention and stability. Presence of torus palatinus is one of the major problems for retention and stability of the maxillary dentures. Torus palatinus provides a challenge when restoring an edentulous arch (Abrams and Hellen, 2006).

Torus palatinus is an intra oral palatal bony outgrowth. It is located at the junction of the palatine process of the maxillary bones in the midline of the palate. The theory of the origin of palatal tori is that of continued growth of the palatal process of the maxilla resulting in lipping and down growth into the palatal vault, which becomes lobular through expansion (Topazian and Mullen, 1977). Torus palatinus varies in shape and size and is directly related with retention and stability of the denture (Basker and Davenport, 2002a). In torus palatinus patients, there is no more or less denture bearing area than normal patients. Therefore, the presence of torus palatinus may affect denture retention by influencing its design (Allen and McCarthy, 2003b).

The full palatal coverage on maxillary complete denture is made with post-dam extending to the vibrating line for posterior palatal seal and for maximum distribution of occlusal load and retention (Hayakawa *et al.*, 2000). This conventional denture interfered with the perception of heat and taste (Zarb, 1983) and induced gagging reflexes (Conny and Tedesco, 1983). Although the full palatal coverage up to the vibrating line had the positive influence on the retention of maxillary complete dentures, the effectiveness of even the palateless dentures (horse-shoe) had also been reported (Floystrand and Orstavik, 1984). On several occasions when the palatal plate was partly reduced, the patients found the dentures improved with comfort, taste perception and satisfaction but leads to poor retention (Zarb, 1983).

Removal of the entire palatal plate may cause the denture wearing patient to be less confident and the dentists may as well have anxieties over the retention and stability of dentures. It would be logical to place the posterior border of the denture on the

compressible tissues rather than the hard structure like palatal rugae for favor of the retentive air tight seal (Krizan and Panduric, 1991). Therefore, it is important to ensure maximum extension of the dentures so that the optimum retention for the particular patient may be obtained.

Since a torus palatinus is covered by a thin and relatively incompressible layer of mucosa, it may lead to problems of discomfort, instability and midline fracture of the upper denture (Basker and Davenport, 2002b). Mucosa can be easily injured because of the pressure from a denture and it can lead to ulceration (Rahn and Heartwell, 1993). The thinner the saliva films between the denture and underlying mucosa, the greater the forces of retention. The presence of torus palatinus can affect the salivary film thickness resulting in lack of retention (Basker and Davenport, 2002a). Although torus palatinus is a benign condition, it may give rise to speech difficulty and hyperkeratosis, and ulceration of the overlying mucosa may occur (Solomon, 1973). Other than that, torus palatinus usually present with some undercuts to the path of insertion and removal of the denture (Rahn and Heartwell, 1993).

Although the presence of torus palatinus in dentate people has no impact on oral functions, it can be annoying to complete or partial denture wearers and may interfere with the construction of removable prostheses. Small tori that do not act as fulcrum points under a denture may not require removal. The torus however, even when small, may act as a fulcrum under a denture if the mucosal covering of the crest and slopes of the ridges are displaceable to a greater extent than the mucosal covering the torus. In these instances, the denture base over the area must be relieved

to compensate for the difference. When a torus is large, has gross undercut, or located posteriorly, it should be surgically removed (Rahn and Heartwell, 1993).

Torus palatinus can be diagnosed clinically and no biopsy is necessary. Surgical removal is not required unless in cases of chronic trauma or interference with oral function or with the replacement of a denture base or frame work (Jainkittivong *et al.*, 2007). So, the construction of complete denture should be carried out carefully for torus palatinus patients.

1.2 Statement of the Problem

The patient with torus palatinus may be having difficulty in the construction of dentures (Miglani, 1959). In partially or fully edentulous individuals, torus palatinus can cause loss of stability or lack of retention of the upper denture (Solomon, 1973). When torus palatinus becomes large, they may interfere with denture placement (Al Quran and Al-Dwairi, 2006). In fully edentulous individuals, torus palatinus can cause loss of stability, lack of retention and less satisfaction when patient wearing maxillary complete denture. Therefore, evaluation for the size of torus palatinus in relation to the performance of maxillary complete denture is required. At present, no study has been carried out to evaluate the retention, stability and satisfaction of patients wearing maxillary complete denture in relation to the presence of different sizes of torus palatinus.

1.3 Justification of the Study

Denture patients are the most affected by the presence of torus palatinus as compared to other patients. To our limitation of knowledge, no data is available to correlate the

retention, stability and satisfaction of wearing maxillary complete denture among patients with different sizes of torus palatinus. The results of this study will hopefully help the clinicians to correlate and possibly manage the maxillary complete denture construction in patients with different sizes of torus palatinus.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

The two most common intraoral osseous outgrowths are torus palatinus and torus mandibularis (Antoniades *et al.*, 1998). Late 19th and early 20th century researchers associated torus palatinus with a variety of factors, including syphilis, tuberculosis, rickets, scurvy, cancer, insanity and criminality (Woo, 1950). Torus palatinus can be defined in many different ways. The most commonly used definition describes it as slow growing, osseous outgrowths at the midline of the hard palate (Bruce *et al.*, 2004). Suzuki and Sakai (1960), stated that torus palatinus is a spindle-shaped bony elevation along the midline of the vault of the palate. Torus palatinus is also defined as non-neoplastic and self-limiting simple bony outgrowths that may vary in shapes and sizes along the midline of the hard palate (Yaacob *et al.*, 1983). Gorsky *et al.*, (1996), defined the torus palatinus on actual measurement. A nodular bony mass of more than 3 mm posteroanteriorly on the midline of the hard palate was considered a torus palatinus. Etiology, shapes, sizes and prevalence of torus palatinus and factors affecting dentures are important aspects in a study regarding torus palatinus.

2.2 Histology

Torus palatinus consists of both compact and cancellous bony tissues (Jainkittivong and Langlais, 2000, Vidic, 1966) and is formed by the hypertrophy of the spongy and oral compact layers. The nasal compact layer remains unchanged (Vidic, 1966). Similarly, torus palatinus consists of a thick layer of compact osseous substance at the oral or inferior surface of the palate and it contains a spongy substance in the centre and again a layer of compact bone forming the nasal or superior surface. The

torus palatinus is not produced by a bending downwards of the palatine process; the floors of the nasal fossae remain either flat or hollowed only to a normal extent. It is essentially a projection downwards of a dipole, through the compact layer on the oral surface varies considerably in thickness (Woo, 1950).

A microscopic view of a cross-section through the middle of a palatine torus showed that the pressure lamellae are arranged in antero-posteriorly direction from the incisive foramen to the posterior margin of the hard palate (Woo, 1950).

In a cross-sectional study on torus palatinus, an overgrowth of the oral compact layer and the spongy layer can be seen but the sponge layer may not be seen in small torus palatinus (Seah, 1995).

2.3 Etiology of torus palatinus

Torus palatinus is a benign feature that shows extensive variation in both frequency of occurrence and expression among populations of the world. In general, the etiology of torus palatinus is not well understood (Cagirankaya *et al.*, 2004) and researchers continue to debate the relative importance of genes versus environment in its expression (Woo, 1950). Torus palatinus should be considered a dynamic phenomenon, responding during life to environmental and functional factors and acting as a complicated interplay with genetic factors (Haugen, 1992, Gorsky *et al.*, 1996). The etiology of torus palatinus has been investigated and several factors have been proposed including genetic, environmental, masticatory hyperfunction and continued growth. Torus palatinus is considered to be a developmental anomaly,

although it does not present until adult life and often will continue to grow slowly throughout life (Bouquot, 1986).

Although the exact cause of appearance of the torus palatinus is not clear, the most widely accepted theory is genetic. But it has not always been possible to show the autosomal dominant nature of its appearance (García-García *et al.,* 2009). Gorsky *et al*., (1996), proposed that torus palatinus may result from an autosomal dominant genetic trait. Recently, the etiology of torus palatinus has been postulated to be an interplay of multi factorial genetic and environmental factors (Haugen, 1992, Gorsky *et al.,* 1996, Gorsky *et al.,* 1998).

Torus palatinus is considered to be an interplay of genetic and environmental factors with a familial occurrence suggesting autosomal dominant inheritance with reduced penetrance (Al Quran and Al-Dwairi, 2006). Eggen *et al*., (1994), found that torus palatinus seemed likely to arise from a multifactorial liability, with part of the genetic factors residing on the X chromosome and they found a relationship between the presence of torus palatinus and the number of teeth present in the mouth. King and Moore (1976), concluded that etiology of torus palatinus results from environmental factors that is related to mechanical stress. Reichart *et al.* (1988), stated that significant correlation between the incidence of torus palatinus and the presence of abraded teeth and they concluded that dietary habits and nutritional disturbances are considered to be an etiology of torus palatinus. Torus palatinus is a benign hyperplastic over growth of the bony surface which is also considered as developmental anomaly that can be differentiated from a true neoplasm. Several factors affecting the development of torus palatinus have been proposed and the

major ones being genetics, environmental, masticatory stress, 'marine diets' and the number of existing teeth (Bruce *et al.*, 2004). Although the etiology of torus palatinus is not fully known, it can be due to functional response, sex, race and heredity (Miglani, 1959). Torus palatinus was considered as the dominant inheritance because when the children have torus palatinus, 85.7% of their parents like wise have torus palatinus (Suzuki and Sakai, 1960).

Another cause of torus palatinus is superficial injuries or its occurance as a functional response in individuals with well-developed chewing muscles or in patients with abraded teeth due to occlusion (García-García *et al.*, 2009). Based on the previous studies, the etiology of torus palatinus is still controversial and it can be considered as multifactorial with some involvement of genetic factors.

2.4 Shape and size of torus palatinus

2.4.1 Shape

There are various shapes of torus palatinus (Basker and Davenport, 2002a). The following criteria were used to classify different shapes of torus palatinus:

1. Flat Torus- occurs as a slightly convex protuberance with a smooth surface.
2. Lobular Torus- presents as a pedunculated or sessile lobular mass that can arise from a single base.
3. Nodular Torus- occurs as a multiple protuberance, each with individual base. These protuberances may coalesce to form grooves between them.
4. Spindle Torus- presents along the midline ridge of the palatal raphe (Al Quran and Al-Dwairi, 2006).

Cagirankaya *et al.*, (2004), documented that torus palatinus can be presented clinically in different shapes, which can be described as spindle, nodular, or lobular. Gorsky *et al.,* (1996) reported that different shapes of torus palatinus have been found but the smooth type was more common than the lobular type in an Israeli population study.

Bernaba (1977), stated that the nodular and lobular forms of torus palatinus was not common but the flattened forms was predominant in their study. The shape of torus palatinus were nearly always a smooth convex projection into the mouth, however, a few cases of spindle and lobular torus palatinus were also found in American and British population (King and Moore, 1976). In another study, the flat torus palatinus was the rarest type in Thai population (Apinhasmit *et al.*, 2002). Chew and Tan (1984), classified the shapes of torus palatinus into well or ill-defined borders. The measurements are more than 15 millimeters (mm) x 10 millimeters (mm) for well-defined and less than 15 mm x 10 mm for ill-defined shapes respectively. Ill-defined torus palatinus was more commonly found in their study. Torus palatinus presents either as a smooth bulging of the bone surface continuous with the adjacent area or as discrete, multi-locular, spherical projections with a broad base that forms a nodular cluster (Bruce *et al.*, 2004). Eroglu and Erdal (2008), divided the torus palatinus into 5 categories: absent, trace, medium, strong and excessive. However, Suzuki and Sakai (1960) reported three categories of torus palatinus: trace (not discernible by sight but clearly recognized by palpation), slight (discernible by sight) and marked (particularly remarkable) that were used for palpation and visual inspection of torus palatinus.

Finally, Landa (1951), classified types of torus palatinus into long and narrow, short and wide and consist of one large bony protuberance or of several small ones fused together and assuming the shape of a mushroom. In most cases, the base of the torus is wide and it tapers upward. The results of the above studies showed the shape of torus palatinus varied in various populations.

2.4.2 Size

In Yugoslavian population, the size of torus palatinus depends on the elevation from the palate; a small torus (up to 3 mm in elevation from the palate) and a large torus (more than 3 mm in elevation from the palate) (Vidic, 1966). The torus palatinus measuring more than two centimeters (cm) and below two centimeters (cm) were found and it was also assumed that the size of torus palatinus was related with heredity (Yaacob *et al.*, 1983). Haugen (1992) and Eggen *et al.,* (1994) classify the size into small (less than 2 mm), medium (2mm to 4 mm) and large (more than 4 mm) respectively. Another classification of size of torus palatinus is suggested by Reichart *et al.,* (1998), which classifies them as grade 1, small (up to 3 mm), grade 2, moderate (up to 6 mm) and grade 3, marked (above 6 mm).

Although the majority of the size of torus palatinus in the American study were between 1cm and 2cm, only a few torus palatinus larger than 2cm were recorded in the British study (King and Moore, 1976). In another study, small and medium sizes torus palatinus were mostly found (Apinhasmit *et al.,* 2002). The study concluded that small tori were more common than large tori (Jainkittivong *et al.,* 2007). Among 157 patients, 43 patients with slight torus palatinus, 53 patients with moderate torus palatinus and 61 patients with marked torus palatinus were found (Harris, 1962).

Majority of torus palatinus found in Canary Islands were medium and marked size torus palatinus. They also stated that torus palatinus can extend anteriorly to various degrees onto the palate and in extreme cases terminate beyond the incisive foramen (Halffman *et al.*, 1992). The findings from those studies showed that small size tori are more frequently found than the medium size tori and the large size tori is the least frequent except those found in the Harris study.

2.5 Prevalence

Al Quran and Al-Dwairi (2006) reported that the prevalence of tori in Jordan was only 13.9% while Bruce *et al.*, (2004) found the prevalence to be close to 14.6% in Ghanaian community. In an Israeli population, torus palatinus was present in 21% of all individuals examined among 1002 individuals (463 men and 539 women) (Gorsky *et al.*, 1996). A study carried out in Canary Islands found that the frequency of torus palatinus was 24% (Halffman and Irish, 2004). Harris (1962), stated that 27.44% of torus palatinus was found in Thai children. In another study, the prevalence of torus palatinus was 38.7% among 168 subjects (89 women and 79 men) of the same population (Gorsky *et al.*, 1998). A study in Singapore found that the prevalence was 48% (Chew and Tan, 1984).

Among 400 (200 male and 200 female) well-preserved Yugoslav skulls from the collection of the Department of Anatomy, School of Medicine, University of Zagreb, it was found that 49.75% had torus palatinus (Vidic, 1966). The prevalence of torus palatinus (52.5%) was also noted in some Malaysian population (Yaacob *et al.*, 1983). Jainkittivong and Langlais (2000), reported that the prevalence of torus palatinus may increase with age. Another study conducted on Thais population,

among 1,520 dental patients attending the Faculty of Dentistry, Chulalongkorn University, Bangkok, 920 (60.5%) subjects had torus palatinus (Jainkittivong *et al.*, 2007).

The frequency of torus palatinus among the ancient Anatolian populations is 62.8% (Eroglu and Erdal, 2008). There is one study in which torus palatinus was not found in the 1000 Pre-Columbian skulls (Sawyer *et al.*, 1979). The high prevalence of torus palatinus should be considered due to multifactorial genetic and environmental factors (Yildiz *et al.*, 2005).

2.6 Age

Torus palatinus was found in a fetal palate (Woo, 1950). A study done in Naradhivas, Thailand also stated that the occurrence of torus palatinus was found to be the highest in the first two decades of life but 165 torus palatinus was found in 4 to 6 year old kindergarten children (Harris, 1962). Bernaba (1977), found that torus palatinus did not occur in individuals less than 10 years of age. Another study stated that torus palatinus is not present until the late teen and early adult years. It may continue to slowly enlarge over time. Torus palatinus can be mostly found during the second or third decade of life, but may also be noted at any age (Gorsky *et al.*, 1998). Another study stated that, fewer than 3% of torus palatinus occur in children, but at least 3% of adult were affected (Bouquot, 1986). Small-sized torus palatinus can also be found in the first and the second decades of life (Apinhasmit *et al.*, 2002). The most common age range for the onset of torus palatinus is from 11 to 20 years old (Reichart *et al.*, 1988). The larger tori were observed in individuals aged 21 years and older. It can be assumed that the occurrence of torus palatinus larger than 2cm

also increases with age (Gorsky *et al.*, 1996). Torus palatinus has been considered to increase in size during early adult and middle life, but growth stops after that (Haugen, 1992).

The highest occurrence of torus palatinus was found in the 20–29-year-old individuals (Jainkittivong *et al.*, 2007). Likewise, torus palatinus can be found in persons below the age of 30 years which was higher in a Malaysian study (Yaacob *et al.*, 1983). The occurrence of torus palatinus increases with age, achieving a plateau by the third decade (Jainkittivong and Langlais, 2000). The frequency of torus palatinus in Anatolian skeletal populations is lower in younger individuals but the frequency rises in middle-aged individuals and declines slightly in individuals at advanced age (Eroglu and Erdal, 2008). According to a study done by Bruce *et al.*, (2004), the youngest person with a maxillary torus was found in 19 years of age and the oldest was 65 years. Midpalatal torus started from 15-19 years of age and peak at the age of 30-39 years old. However, another study showed that the highest occurrence of torus palatinus was in the third decade of life. Other data obtained from Northern and Southern Thailand showed that the peak incidence was in the fourth decade (Kerdpon and Sirirungrojying, 1999).

Individuals in the older age group was more likely to have large-sized torus palatinus than adults and the peak of occurrence of torus palatinus was in the fifth decade (Apinhasmit *et al.*, 2002). The occurrence of torus palatinus appeared to be stable during the middle phases of life (30 to 59 years) but increased slightly in the 60 years and older age group. The prevalence of torus palatinus increases with age thus indicating a relationship between age and the occurrence of torus palatinus

(Jainkittivong and Langlais, 2000). The highest incidence was found in subjects 60 years and above (Jainkittivong *et al.*, 2007). In the study conducted by Haugen *et al.*,(1992), the onset of torus palatinus started at 65 years old.

Torus palatinus appears during puberty and slowly grows until the subject reaches adulthood, with the possibility of their growth continuing until the seventh decade of life (MacInnis *et al.*, 1998). Torus palatinus was found among the 10-80-year-old patients (Kerdpon and Sirirungrojying, 1999). In addition, torus palatinus were significantly noted in individuals over 80 years of age (Al Quran and Al-Dwairi, 2006).

The age-related difference with the size of torus palatinus was also noted. Subjects who had larger torus palatinus were generally older than subjects who exhibited smaller torus palatinus. These findings supported an association between age and the continued growth of tori (Jainkittivong *et al.*, 2007). There is some disagreement among authors as to the age at which torus palatinus is usually first observed, but this can be expected since its growth does appear to be extremely slow (Eroglu and Erdal, 2008). The controversy regarding age and occurrence of torus palatinus still persist between researchers. However, available studies showed that torus palatinus can generally be found in adults and in particular around mid-life.

2.7 Ethnic

Gorsky *et al.*, (1996) stated that torus palatinus was noted in 21% of the study group with significant differences in the occurrence in the Ashkenazi, Sephardi, and Oriental Jewish ethnic groups. The prevalence of torus palatinus in Malays is the

highest compared to Chinese and Indians. They concluded that the prevalence of torus palatinus is higher in Asians and Eskimos (Yaacob *et al.*, 1983). Other researchers assumed that the prevalence is generally higher in Mongoloids than in Caucasians in their study (Chew and Tan, 1984). A study done on the German and Thai populations found that Mongoloids and Eskimos appear to have a higher prevalence of torus palatinus than other races (Reichart *et al.*, 1988). Meanwhile, the prevalence of torus palatinus was slightly higher in African-Americans than Hispanics, according to a study conducted at the Howard University, Washington DC (Chohayeb and Volpe, 2001). A study done in Southern Thailand concluded that torus palatinus was commonly found in Chinese than Thai (Harris, 1962). The occurrence of torus palatinus was higher in Asians and Mongoloids but lower in African and African-derived populations (Woo, 1950).

2.8 Gender

An Israeli study stated that there was no significant difference in the occurrence of torus palatinus between females and males (Halffman *et al.*, 1992). In addition, a Singaporean study also found that the ratio of males to females was the same (Chew and Tan, 1984). Another Israeli study found that torus palatinus was more common in women than in men (Gorsky *et al.*, 1996). Bouquot (1986), also stated that torus palatinus was more common in females than in males. Similarly, in a Norwegian study, the prevalence of torus palatinus was found to be higher among women than men (Eggen *et al.*, 1994). The study was supported by American and United Kingdom studies. There was a much higher incidence of torus palatinus in females than males among the American and United Kingdom populations (King and Moore, 1976). Likewise, of the 609 subjects examined in a study, torus palatinus is present in

183 males and 426 females. The male to female prevalence ratio was 1:1.4 (Kerdpon and Sirirungrojying, 1999). A study done in the Thai population found that the prevalence of torus palatinus is 2.2 times more common in females than males (Apinhasmit *et al.,* 2002). Furthermore, torus palatinus was observed more frequently in women than in men (70.5% vs. 48.8%) among 1520 subjects. The female to male ratio stood at 1.5:1 (Jainkittivong *et al.*, 2007). Another study also supported the fact that the prevalence of torus palatinus occurred twice as often in females as in males (Schaumann *et al.*, 1970). Harris (1962), stated that among the Chinese, males and females are equally affected but females were twice affected than males among the Thais (Harris, 1962).

A study on the Malaysian population showed that the females of each race were affected more often than males (Yaacob *et al.*, 1983). The female to male ratio was calculated to be 2.3:1 in Malays, 1.7:1 in Chinese and 1.5:1 in Indians. The Malay females were about twice more frequently affected than the Chinese or Indians females (Yaacob *et al.*, 1983). Another study conducted that females had 2.2 times the probability of having torus palatinus compared to males (Bruce *et al.*, 2004). In males, 38.5% displayed a small torus, and 3.5% a large torus, whereas in females, 52.5% displayed a small torus and 5% a large torus. In addition, large size torus was found more common in women than in men. It is believed that these may be related to the dominant type linked to the X chromosome (Vidic, 1966).

Reversely, some study concluded that frequency of occurrence of torus palatinus is higher in males than in females (Bernaba, 1977). A study done in Pre-Columbian Peruvians from Northern Peru also found a higher prevalence in males (Sawyer *et*

al., 1979). Another study found that torus palatinus was present more often in male than in females in Canary Islands (Halffman and Irish, 2004). In a study of an ancient Anatolian population, frequency of torus palatinus was slighty higher in males (63.2%) than females (62%) but no statistically significant difference was found between sexes (Eroglu and Erdal, 2008). The findings from those studies showed that the occurrence of torus palatinus among female and male is still a controversy.

2.9 Location of torus palatinus

Chew and Tan (1984), studied the location of torus palatinus among 200 patients. They found that 37% of torus palatinus were located in the posterior two thirds and 34% were located in the middle third of the palate. Others were located in the anterior two thirds (20%), posterior one third (7%), and anterior one third (2%) of the palate.

Regarding the location of the torus palatinus, one study found that the most common location of torus palatinus was at the premolar region (47.4%), followed by the premolar to molar region (46.4%). The less common locations were at molar and other regions (6.2%) (Jainkittivong *et al.*, 2007). This study concluded that torus palatinus is mostly found at the premolar region rather than incisor and molar regions.

2.10 Diagnosis

In most cases, the finding is usually incidental and observed during clinical examination at the dental office. This is because they are asymptomatic for the most part and those who have torus are not aware of it. They are diagnosed by clinical

examination and radiographic examination. X-rays reveal radiodense images with a slightly higher density than that of the surrounding bone (Seah, 1995).

2.11 Denture

The term ‘prosthesis’ may be defined as an artificial replacement of an absent part of the human body (The Academy Of Prosthodontics, 2006). The dental prosthesis are the artificial devices replacing the lost or missing natural teeth and their associated parts to restore impaired function, appearance, comfort and health of the patient. The dentures belong to the art and science of the restoration of a partially edentulous or totally edentulous mouth (Boucher, 1970). There are two types of dentures. They are partial denture and complete denture. Partial denture is a removable dental prosthesis that restores one or more but not all of the natural teeth. Complete denture is a removable dental prosthesis that replaces the entire dentition. Polymer base (Acrylic complete denture) and metal based (cobalt-chromium complete denture) are two types of complete denture (Chestnutt and Bibson, 2002).

2.12 Principles of complete denture

The retention and stability of the total dentures remain crucial for the success of the total denture treatment despite the innumerous technical and scientific achievements (Dimova *et al.*, 2005). There are 3 key principal factors in the prescription and provision of successful complete dentures. They are retention, stability and support. The relationship between these factors is also important. Generally, denture fit is usually described in terms of retention and stability. Retentive complete dentures are reliant on the interplay between factors of retention and stability (Rendell *et al.*, 1995). Complete dentures are made up of 3 surfaces; the impression or intaglio

surface, the polished surface, and the occlusal surface. The retention, stability, and support of the dentures are governed by the design of these 3 surfaces. When the maxillary and mandibular denture teeth come into contact, unfavorable displacing forces may overwhelm the retention and stability of the dentures, resulting in discomfort from trauma to the supporting mucosa. If the intaglio and polished surfaces are ideal, it is assumed that the form of the occlusal surfaces and the nature of their contacts become critical for successful complete denture function (Sutton, 2007).

Retention is usually the distinguishing factor between success and failure of dentures (Wright, 2004). Retention is defined as the resistance by the denture to removal from the mouth which can be detected by firmly seating the denture in the mouth and trying to displace it with a force at right angle to its occlusal surface. If the denture resists displacement, it has adequate retention (Watt and MacGregor, 1986). Retention depends on peripheral seal, contact area between denture and tissues, close fit and viscosity of saliva (Yemm, 1985).

Denture retention denotes the force required to completely remove a denture from its basal seat. Physical factors that influence retention are as follows: adhesion (the bond between mucosa membranes and the denture) and cohesion (the molecular bond between saliva or water), negative atmospheric pressure under the denture, capillary action (the narrower the space between the denture and mucosa, the more retention occurs) and viscosity of saliva (responsible for initial retention and helps to prevent dislodgement of the denture) (Bla'hova' and Neuman, 1971). Influence of adhesive and cohesive forces, surface tension, atmospheric pressure, viscosity and volume of

saliva, and gravity are important for denture retention (Kikuchi *et al.*, 1999). The retention of complete dentures is mainly concerned with the physical forces (Saung, 1983). These forces were roughly divided into three groups as surface forces, fluid forces and atmospheric pressure (Watt and MacGregor, 1986). Surface forces are concerned with the adhesion of saliva to the denture and to the mucosa. The salivary meniscus existing between the denture base and the oral mucosa is forced to recede during denture dislodgement. The recession is impeded by the viscosity of saliva and a negative pressure is generated under the denture (Saung, 1983). Retention is mainly associated with fluid flow across the denture margins (Watt and MacGregor, 1986). A sufficient layer of saliva is essential for retention as a result of physical effects. Many models have been devised to determine the relative importance of various physical factors that act through the salivary film at the denture-tissue interface. Changes in the environmental pressure will change the amount of air in the film of saliva, and these changes will affect the retention of complete dentures. Therefore, it is important to have a hermetically sealed denture (Colon *et al.*, 1982). Another factor is that, with a 70% decrease in atmospheric pressure, a 50% decrease in retention was observed (Watt and MacGregor, 1986). Maxillary complete denture retention also depends on the posterior palatal seal which is located at the border of the denture. The posterior palatal seal has been defined as an area of soft tissue along the junction of the hard and soft palate on which pressure, within physiologic limits of tissues, can be applied by a denture to aid in its retention. The retention of the base-plates is to be greatly reduced when there is no peripheral seal (Colon *et al.*, 1982). An adequate seal of the posterior border of a maxillary denture is essential for retention (Ansari, 1997). Function of palatal seal is to provide retention, to prevent food from getting under the denture base, to diminish gagging, to make the sunken

distal border less conspicuous to the tongue and to supply a thick border to counteract denture warpage due to dimensional changes during the curing process (Ettinger and Scandrett, 1980). Denture retention is affect by the following three factors, namely: (1) the closeness of adaptation to the oral mucosa (2) the extent of the denture base and (3) the peripheral seal (Watt and MacGregor, 1986).

Stability is defined as the ability of a denture to remain stationary in relation to the surrounding musculature and opposing occlusal surface (Rendell *et al.*, 1995). Stability relies on resisting forces likely to displace the denture from the denture-bearing tissues (Allen and McCarthy, 2003b). Stability is influenced by the forces acting on polished and occlusal surfaces and form of supporting tissues (Yemm, 1985). A stable denture is one that moves little in relation to the underlying bone during function. Stability is usually the distinguishing factors between success and failure of denture (Wright, 2004). Denture stability is of primary importance for the successful result of the prosthetic treatment of totally edentulous patients (Dimova *et al.*, 2005). The stress causing instability comes from many directions and is created during most of the functions of the mouth. The qualities necessary to create and maintain stability are dependent upon the following factors. (1) retention, (2) diagnosis, (3) the functions of the mouth, (4) the denture base outline, (5) the occlusal plane, (6) the arch arrangement, and (7) instruction and education of the patient (Wright, 2004). The most important factor in denture stability are the contacts and inclination of the posterior artificial teeth and their interrelation to the occlusal plane (Dimova *et al.*, 2005). From the above studies, the factors of denture retention and stability of complete denture are complex.

Retention and stability of dentures can be determined by following a scoring method as described in Table 2.1 (Kapur, 1967).

Table 2.1: Scoring method for retention and stability

Score	Retention criterion	Stability criterion
0	No retention. When a denture is seated in its place, it displaces itself.	No stability. When a denture base demonstrates extreme rocking on its supporting structures under pressure.
1	Minimum retention. When a denture offers slight resistance to vertical pull, and little or no resistance to lateral force.	Some stability. When a denture base demonstrates moderate rocking on its supporting structures under pressure.
2	Moderate retention. When a denture offers moderate resistance to vertical pull, and little or no resistance to lateral force.	Sufficient stability. When a denture base demonstrates slight or no rocking on its supporting structures under pressure.
3	Good retention. When a denture offers maximum resistance to vertical pull and suffieicnt resistance to lateral force.	

Clinically poor dentures = Sum score of < 6
Clinically fair dentures = Sum score of 6-8
Clinically good dentures = Sum score of >8

Another method of assessing retention and stability of complete dentures is by using the National Health and Nutrition Survey (NHANES) III criteria. A complete denture is considered stable when it moves 2 mm or more in one direction and the denture is manually moved laterally. A complete denture is considered retentive when it does not dislodge when the examinee opens the mouth wide without strain (Hummel *et al.*, 2002).

The biological aspects of the relationship between the denture base and supporting tissues are also important for complete denture. Those tissues must be able to tolerate functional stresses without promoting patient discomfort and should be recorded in

such a manner that these areas provide complete denture support. Anatomic regions that satisfy the requirements for providing primary support should make positive contact with the denture base under functional loading. Those that are less resistant to long-term changes or are unable to tolerate stress should be relieved of excessive contact with the denture base. Selection of those regions that should provide primary and secondary support depends on the anatomic variations unique to each patient (Jacobson and Krol, 1983).

Finally, torus palatinus causes the following problems. Torus palatinus can physically interfere with the functions of speech, deglutition, or mastication. It may also pose the problems of continued irritation, interferes with oral hygiene and difficulty in fabrication of a prosthesis (Topazian and Mullen, 1977). The posterior border and the posterior palatal seal are two of the most critical areas for retention of maxillary complete denture. Torus palatinus tend to have large undercuts preventing the creation of a good palatal seal (Abrams and Hellen, 2006). Another study also stated that very large torus palatinus can interfere with the function and placement of dentures. Moreover, recurring traumatic surface ulceration may occur (Bouquot, 1986). Furthermore, the presence of torus palatinus may affect denture retention by influencing its design (Allen and McCarthy, 2003b).

Although torus palatinus is benign bony exostoses, it may need to be removed if it interferes with the construction of dental prostheses (Gores, 1968). Torus palatinus may interfere with the construction and functions of removable dentures as well as oral functional movement. Furthermore, they may hinder prosthetic work (Yildiz *et al.*, 2005).